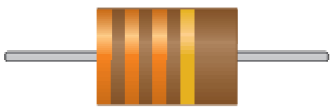
IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

DC Circuits

1) Resistors 'R'

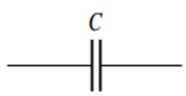
Function : resist or limit electrical current in a circuit .
Unit : ohm 'Ω'

Representation  Symbol 

Note : parameters associated with a resistor 1) length (l) 2) cross-section area (A) .

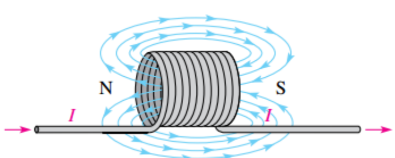
2) Capacitors 'C' OR called condensers

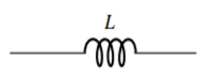
Function : store electrical charge .
Unit : Farad 'F'

Representation Symbol 

3) Inductors 'L' or called coils

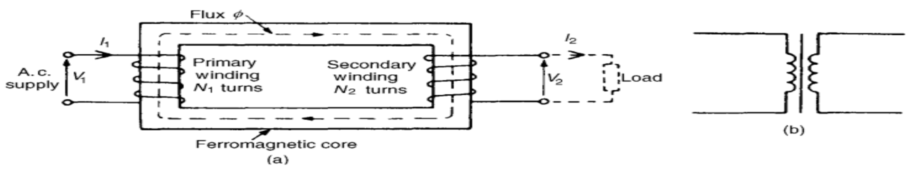
Function : used to store energy in an electromagnetic field .
Unit : Henry 'H'

Representation 

Symbol 

4) Transformers

Function : they are used to couple ac voltage from one point in a circuit to another , or to increase or decrease the ac voltage .



Electronic Devices :

1) Voltmeter : measure voltage .
2) Ammeter : measure electrical current .
3) Ohmmeter : measure resistance .
4) Multimeter : measure voltage, electrical current, electrical current .
5) Oscilloscope : it is an instrument that measures and observes ac voltage .

Electrical units : electrical quantities & their correspond with SI (System International) symbols .

Note : time is not an electrical quantity .

QUANTITY	SYMBOL	SI UNIT	SYMBOL
Capacitance	C	Farad	F
Charge	Q	Coulomb	C
Conductance	G	Siemens	S
Energy (work)	W	Joule	J
Frequency	f	Hertz	Hz
Impedance	Z	Ohm	Ω
Inductance	L	Henry	H
Power	P	Watt	W
Reactance	X	Ohm	Ω
Resistance	R	Ohm	Ω
Voltage	V	Volt	V

Powers of ten (Scientific notations):

Some positive and negative powers of ten.

$10^6 = 1{,}000{,}000$	$10^{-6} = 0.000001$
$10^5 = 100{,}000$	$10^{-5} = 0.00001$
$10^4 = 10{,}000$	$10^{-4} = 0.0001$
$10^3 = 1{,}000$	$10^{-3} = 0.001$
$10^2 = 100$	$10^{-2} = 0.01$
$10^1 = 10$	$10^{-1} = 0.1$
$10^0 = 1$	

Engineering notation : is a special case of scientific which uses powers of three & its doubles and called metric prefixes ($10^{\pm 3}$, $10^{\pm 6}$, $10^{\pm 9}$, $10^{\pm 12}$)

Metric prefixes :

METRIC PREFIX	SYMBOL	POWER OF TEN	VALUE
femto	f	10^{-15}	one-quadrillionth
pico	p	10^{-12}	one-trillionth
nano	n	10^{-9}	one-billionth
micro	μ	10^{-6}	one-millionth
milli	m	10^{-3}	one-thousandth
kilo	k	10^{3}	one thousand
mega	M	10^{6}	one million
giga	G	10^{9}	one billion
tera	T	10^{12}	one trillion

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Voltage 'V' : is expressed as energy divided by charge .

$$V=W/Q$$

Sources of voltage :-

* Battery : converts chemical energy into electrical energy .
* Electronic power supply : converts ac to dc .
* Solar cell : converts light into electrical energy .
* Electronic generators : converts mechanical energy into electrical energy .

Current : rate of flow of charges .

$$I=Q/t$$

Resistance : is opposition to current .

$$R=V/I$$

Types of resistors :

1) Fixed resistors :
    a) Carbon resistors
    b) Wire wound resistors
2) Variable resistors :
    A)
        a) Potentiometer
        b) Rheostat

    B)
        a) Thermistor
        b) Photoconductive cells

Resistor color codes :-

First two bands represent value .
Third represents multiplier .
Fourth for tolerance .

band color	Tolerance
Gold	± 5%
Silver	± 10%
No-band	± 20%

Digit	Color
0	black
1	Brown
2	Red
3	Orange
4	yellow
5	green
6	Blue
7	Violet
8	Grey
9	White

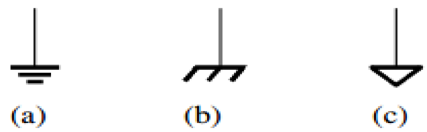
Note : if the third band was gold or silver they are calculated as multiplier , where gold = -1 , silver = -2

Label resistors :-

First three Numbers or Symbols represents value .
Fourth for multiplier.
Fifth for tolerance.

Symbol	F	G	J	K	M	R
Percentage tolerance	±1%	±2%	±5%	±10%	±20%	. (decimal dot)

Ground : is the reference point in electric circuit and has a potential of '0V' wrt other points .



▲ FIGURE 47

Commonly used ground symbols.

Symbol

Ohm's law: states the current varies directly with voltage & inversely with resistance .

$$I = V/R$$

Energy 'W': is the fundamental ability to do work .

Power 'P': is the rate at which energy is used .

$$P = W/t$$

Power rating of resistors 'P_r': it's the max amount of power that resistor can dissipate without being damaged .

Power dissipate : is the consumed power .

Note : power rating must be greater than power dissipate otherwise the circuit is subjected to resistor failure & resistor is damaged .

Note : In problems, if resistor is damaged we consider it short circuit not open circuit .

Series circuit

Series circuit : it's a circuit, which provides only one path for current between 2 given points in a circuit, so the current is the same through each series resistor.

$$I_T = I1 = I2 = I3 = \dots = I_n$$

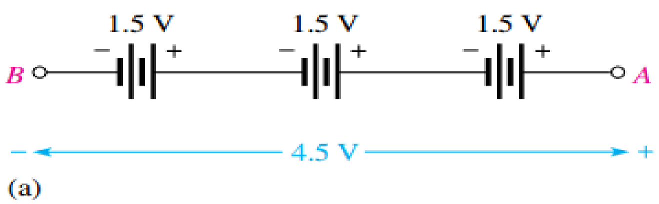
* The total resistance of a series circuit is equal to the algebraic sum of resistances of each individual resistor .

$$R_t = R1 + R2 + R3 + \dots + R_n$$

$$R_t = n * R \rightarrow \text{IF } R1 = R2 = R3 = \dots = R_n$$

Ohm's law : - $I = V_s / R_t$

Voltage sources in series : when 2 or more voltage sources are in series , the total voltage is equal to the algebraic sum of the individual source voltages .

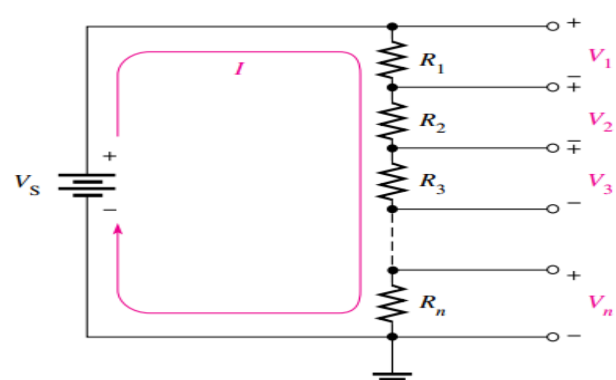


▲ FIGURE 22

Voltage sources in series add algebraically. If a source is reversed, it subtracts from the total voltage as shown in part (b). This is not a normal configuration for batteries.

Kirchhoff 's voltage law : the sum of the voltage drops equals the total voltage source .

$$V_s = V1 + V2 + V3 + \dots + V_n$$



Voltage divider :

$$V_x = (R_x / R_t) * V_s$$

Power in a series circuit : the total amount of power in a series resistive circuit is equal to the sum of the powers in each resistor in series .

$$P_t = P1 + P2 + P3 + \ldots + P_n$$

$$\underline{\text{where}}\ P_x = IV_x = i^2R_x = (V_S)^2/R_x$$

$$\underline{\text{OR}}\ P_t = IVs = I^2Rt = (V_s)^2/R_t$$

Parallel circuit

Parallel circuit : *it's a parallel circuit has more than one current path(branches) between 2 given points .*

Voltage drop in parallel circuits : *the voltage across any given branch of a parallel circuit is equal to the voltage drop across each of the other branches in parallel .*

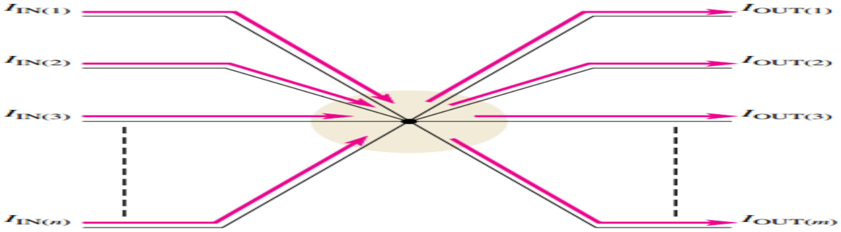
$$V_s = V1 = V2 = V3 = \ldots = V_n$$

Kirchhoff current law : *the sum of the currents into a junction '$I_{T'in'}$' is equal to the sum of the currents out of that junction '$I_{T'out'}$' .*

$$I_T = I1 + I2 + I3 + \ldots + I_n$$

$$I_{T'in'} = I_{T'Out'}$$

$$I_{1'in'} + I_{2'in'} + I_{3'in'} + \ldots + I_{n'in'} = I_{1'Out'} + I_{2'Out'} + I_{3'Out'} + \ldots + I_{n'out'}$$



please take some break :)
it's the last part .

Total parallel resistance :-

$$I_T = I1 + I2 + I3 + \dots + I_n$$

$$\frac{V_S}{R_t} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} + \cdots + \frac{V_n}{R_n}$$

But $Vs = V1 = V2 = V3 = \dots = V_n$

Then

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}$$

Then

$$\boldsymbol{R_T} = \frac{\mathbf{1}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}}$$

Special Cases

$R_T = R/n$ → IF $R1 = R2 = R3 = \dots = R_n$

$\boldsymbol{R_T} = \frac{\boldsymbol{R_1 * R_2}}{\boldsymbol{R_1 + R_2}}$ → IF $R1 \neq R2$, TWO RESISTORS ONLY

Ohm's law : - $I = V_s/R_t$

Current divider :-

$$I_X = \left(\frac{R_T}{R_X}\right) \times I_T$$

$$I_1 = \left(\frac{R_2}{R_1 + R_2}\right) \times I_T$$

$$I_2 = \left(\frac{R_1}{R_1 + R_2}\right) \times I_T$$

** ف البسط المقاومة البعيدة ع مجموع المقاومتين , لو اكتر من مقاومتين باجيب المقاومة المكافئة للكل عدا المقاومة اللي عاوز احسب التيار فيها (اشيل المقاومة 2 و احط مكانها المقاومة المكافئة)

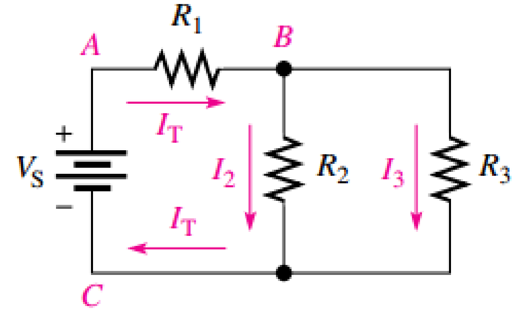
Power in parallel circuits :-

$$P_t = P1 + P2 + P3 + \ldots + P_n$$

Where $P_x = IV_x = i^2R_x = (V_S)^2/R_x$

OR $P_t = IV_s = I^2R_t = (V_s)^2/R$

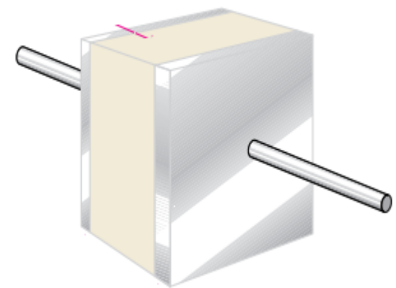
SERIES-PARALLEL CIRCUITS



Series parallel circuits : A circuit consists of combinations of both series & parallel current paths .

$$R_{2.3} = \frac{R_3 * R_2}{R_3 + R_2} \quad ; \quad R_T = R_1 + R_{2.3}$$

Capacitors



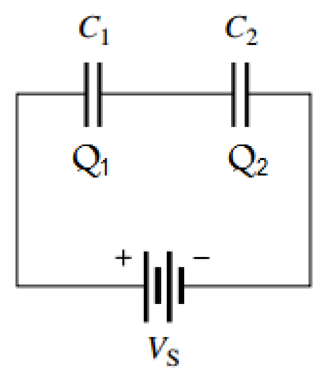
Capacitance

$$C = Q/V$$

The formula for the energy stored by a capacitor :

$$W = \tfrac{1}{2}CV^2 = \tfrac{1}{2}Q^2/C = \tfrac{1}{2}QV$$

Series capacitor :-



While charging , I=Q/t is the same in circuits , so

both capacitors store the same

amount of charge

$$VS = V1 + V2$$

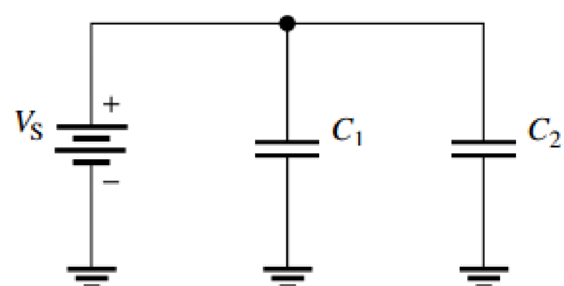
$$VS = QT/CT$$

By applying KVL ----->

$$QT/CT = Q1/C1 + Q2/C2$$

Parallel capacitors :-

the amount of charge on each capacitor is directly proportional to its capacitance value .



$$C = Q/V$$

$$QT = Q1 + Q2$$

$$CT = C1V1 + C2V2$$

$$\text{But } VS = V1 = V2$$

$$\text{Then } CT = C1 + C2$$

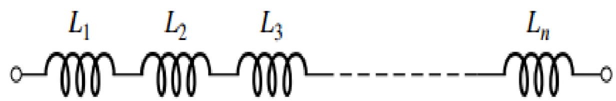
Series-parallel capacitors :-

1) Consider parallel capacitors as series resistances .
2) Consider series capacitors as parallel resistances .

INDUCTORS

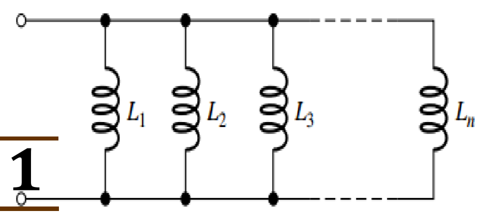
Series Inductors : the total inductance is the sum of individual inductances .

$$LT = L1 + L2 + L3 + \ldots + Ln$$



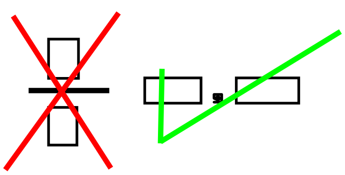
Parallel inductor :

$$L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \cdots + \frac{1}{L_n}}$$



Important notes :

1- يجب ان تكتب القوانين لحساب كل شيء داخل المسالة
2- ان تكتب الوحدات بعد كل ناتج
3- ان تختار اسهل الطرق لحل المسالة الا اذا طلب الحل بطريقة معينة
4- ف النواتج لا يجب ان تكتب ف صورة كسر اعتيادي و لكن كسر عشري
5- عند كتابة ناتج به كسر عشري يكتب العلامة العشرية (.) و ليس (,)
6- ال(,) تستخدم ف الناتج بعد كل 3 ارقام داخل العدد و لايفضل استخدامها ف الامتحان لعدم التشتيت
7- ف مسائل السيريس باراليل يفضل تحويل الدائرة الي ابسط ما يمكن ثم حساب المطلوب مع التوضيح بالرسم خلال كل خطوة من التبسيط



9- PART OF NETWORK THEOREMS IN ANOTHER PDF

WILL BE MADE & UPLOADED SOON

8- والله لازم تكتب القوانين ☺

10- حل الشيتات مهم لان الدكتور عاوز يعرف انت بتذاكر و المحتوي وصلك ولا لأ هو مش بيعملك اختبار ذكاء .

* pictures from floyd

made by TOM

#تم بحمد الله

please read it again , carefully & well-understanding ^-^